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Original Article

The Effect of Weed Control with Common Herbicides on Yield and Components of Soybean Yield (*Glycin max* L.)

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ABSTRACT

In order to investigate the effect of weed control with common herbicides on yield and yield components of soybean (*Glycine max* L.) Williams cultivar, two experiments were conducted using randomized complete block design with three replications at Agricultural and Natural Resources Research Center of Moghan during 2016-2017 and 2017-2018. Treatments consisted of Ethalfluralin, Imazethapyr, Trifluralin, Metribuzin, Bentazone and Alacolor herbicides with and without hand weeding control. The results showed that the number of pods per plant, biological yield, grain yield, and soybean protein percentage were statistically significant, but for plant height, growth period, chlorophyll index, 1000 seed weight and oil percent grain, the difference was not significant. The highest number of pods per plant (333.92), biological yield (1221 g.plant^{-1}) and grain yield (2792 kg.ha^{-1}) were obtained in hand weeding treatment. The results of the analysis of variance showed that the treatments had a significant difference in terms of herbicide efficiency percentage, density, and total weed dry weight. The results showed that one month after spraying, Trifluralin and Ethalfluralin herbicides had the highest effect on weed control. However, two months after herbicides spraying; all other treatments also showed their control effect. In this study, all weed control treatments significantly reduced the density and dry weight of weeds as compared to control treatment, but their effect was less than hand weeding. The highest grain yield (1896 kg.ha^{-1}) and the highest biological yield (784.9 kg.ha^{-1}) were observed in Ethalfluralin herbicide. Generally, based on the results of this study, the application of Ethalfluralin herbicide at rate of 2 L.ha^{-1} could be recommended for effective weed control in soybean production systems.

Key words: Ethalfluralin, Imazethapyr, Protein grain percent, Grain yield

Introduction

Soybean (*Glycine max*) is an important oil seed crop in the world. This plant has a high quantity of protein, edible oil, and used in food industry for many purposes such as the flour, oil, cookies, candy, milk, vegetable cheese, lecithin, and other products. Soybean is an important and useful commodity in livelihood of human being all over the world (Argaw, 2012). Due to the increasing demand limitations associated with cultivation of this crop, identifying the effective and practical factors for increase the yield production per unit area is very crucial. In this regard, pest control and especially weed management is of particular importance in increasing production efficiency (Adhikari *et al.*, 2019). Weeds may cause yield reduction up to 67% depending on the intensity, crop variety, season, soil type, rainfall, duration and period of weed competition (Gaikwad and Pawar, 2002). Weed infestation is persistent and complex constraint in soybean, as it influences soybean growth and development through competition for nutrients, water, light, space and production of allelopathic compounds (Vollmann *et al.*, 2010; Jadhav and Bhosale, 2018). The abundance of some weed species is likely to be strongly influenced by environmental and cultural conditions and its infestation could be more efficiently managed by proper selection of herbicides (Pinke *et al.*, 2016). The presence of weeds in soybeans field reduces seed yield and the amount of this reduction depends on the amount of weeds in the growth stage of the crop (Torun and Uygur, 2019). The critical weed-free period in soybean ranges from 9 to 14 days after emergence (Thurlow and Buchanan 1972; Baysinger and Sims 1991; Van-Acker *et al*., 1993) to 6 weeks after emergence (Fellows and Roeth, 1992). Thus, the critical period is not static and is influenced by several factors, including cropping practices, the time of weed emergence relative to the crop, and the density and type of emerging weeds in the field. Seedlings of young soybeans cannot compete with many of the fast-growing weeds and the control of weeds in this period is very important. Reports from Brazil show a 13 to 89 percent decrease in soybean yields due to non-control of weeds (Adcock and Banks, 2009). It is necessary to achieve the optimum level of suppressive growth of a weed, using special management methods. Weed management methods in soybean are included increasing the density of soybean plant per unit area, using competitive cultivars crop rotation, as well as the mechanical and chemical methods. The use of herbicides for weed management is a major part of many new management systems for weed control. However, weed control programs based only on pre-emergence herbicide is not adequate for providing sustainable weed control because weeds emerging in late season could compete with soybean and reduce seed yield. Furthermore, if farmers couldn't apply pre-emergence herbicides due to unfavorable weather conditions, post-emergence herbicides are needed for managing weeds. Post-emergence herbicide such as bentazone has been registered for weed control in soybean. A pre-emergence followed by post-emergence herbicide program provided better weed control in soybean compared with solely post-emergence herbicide program in several studies in the United States (Taylor-Lovell *et al*., 2002; Jhala *et al*., 2015). (Zarco-Tejada *et al*., 2000) remark that chlorophyll leaves are one of the most important indicators of environmental stresses on the plant and they believed that the amount of chlorophyll in plants under stress and the total absorption of light by the plant could be reduced. (Khakzad *et al*., 2012) found that the combination of Ethalfluralin with Metribuzin either pre-sowing or pre-cultivating caused better control of broad-leaved weeds in soybean fields and highest yield of soybean was obtained from the combination of Ethalfluralin with Metribuzin herbicides in pre-planting. (Jadhav and Gadade, 2012) reported that Imazethapyr+Imazimox at 30 g ha^{-1} and Imazethapyr at 0.1 $kg.ha^{-1}$ as post-emergence application showed the reduction of weed density and weed dry weight. Similarly, (Yousefi *et al.*, 2012) reported that application of imazethapyr at reduced rate greatly affect the growth and biomass production of *X. strumarium* or *A. retroflexus* in soybean as compared to untreated plots. The aim of this study was to investigate the effect of different herbicides on weed control and their effect on some morphological, physiological, yield and yield components of soybeans.

Materials and Methods

In order to investigate the effect of weed control with common herbicides on yield and yield components of soybean yield (*Glycine max* L.) Williams cultivar, two experiments were conducted as a randomized complete block design with three replications at Agricultural and Natural Resources Research Center of Moghan during 2016-2017 and 2017-2018. Treatments were consisted of Ethalfluralin (2 $L.ha^{-1}$ pre-sowing with formulation of 33.3% EC), Imazethapyr (1 $L.ha^{-1}$ post-emergence with formulation of 10% SL), Trifluralin (2 $L.ha^{-1}$ pre-sowing with formulation of 48% EC), Metribuzin (600 $g.ha^{-1}$ pre-emergence with formulation of 75% WP), Bentazone (2 $L.ha^{-1}$ post-emergence with formulation of 48% SL) and Alacolor (3 $L.ha^{-1}$ pre-emergence with formulation of 48% EC) herbicides with and without hand weeding.

The field was planted with wheat at the last year, after harvesting the wheat the straw was left on the ground, tillage was applied and then the field was irrigated uniformly. Then, in mid-July soybean seed (Williams cultivar) was cultivated using a soybean planter. After sowing, the experimental plots were made of 15 m^2 (5×3 m^2). The intervals between the rows were 60 cm, the distance between the plants was 10 cm, the distance between the successive plots in each replicate was one meter and the intervals between the blocks were four meters. The first irrigation was done after planting. Thinning practice was carried out 10 days after planting and in two leaves stage of soybeans. The next irrigation was applied according to the plant's water requirement and the weather conditions. Physicochemical characteristics of the soil are shown in Table 1.

Herbicides spraying were performed using a sprayer equipped with a Tee Jet nozzle 8001 with a pressure of 2 to 2.5 bar and based on 250 $L.ha^{-1}$ water. Criteria for weeds response assessment to applied herbicides using the standard method of the weed Research Committee (EWRC) and at intervals of 30 and 60 days after the application of herbicides. 30 days after spraying, weed sampling was carried out by sampling units (quadrat 0.5 × 0.5 m) and the samples were transferred to the lab and after counting the number of bushes by species, to determine the dry weight, they were placed in an oven for 48 hours at a temperature of 75° C. After complete drying of the samples, the contents of each individual envelope were weighed and the dry weight of the samples was recorded.

Soybean harvest practice was carried out in the middle of autumn when the moisture content of the grains reached about 18%. The soybean parameters measured in this study were included: Plant height at the time of flowering was from the average of 10 plants randomly selected from each plot, the growth period was considered as the number of days from the time of emergence until the seeds were ripened, the chlorophyll content of leaf was measured at the time of flowering at an average of 10 plants, randomly selected from three parts (lower, middle and upper leaves of the plant) using a manual chlorophyll meter (SPAD), the biological yield of the plants (10 plants) was randomly determined from each plot after ripening, the number of seeds per plants per plot was counted from 5 plants when the plants were ripened, the weight of 1000 seeds was determined by weighing 100 seeds and then its generalization to 1000 seeds. To determine grain yield after removal of margins, area of one square meter of each soybean plot was collected and after removing seeds from pods and weighing them, grain yield was a generalization to kilogram per hectare. The protein percentage of seeds was measured by the N.M.R. informatics device in the laboratory. Analysis of variance and all statistical calculations were performed using SAS software. Means were compared by the LSD test at 5% probability level.

Table 1. Physical and chemical properties of the soil from the experimental field

Organic carbon (%)	soil Texture	Salinity (ds/m^{-1})	K (ppm)	P (ppm)	N (%)	Clay (%)	Silt (%)	Sand (%)
0.78	Sandy-loam	0.388	320	4.5	0.064	8	32	60

Table 2. Criteria for weeds response assessment to applied herbicides

Description	Weeds reaction Weed control (%)	Score
wholly controlled	100	1
excellent controlled	96.50- 99	2
good controlled	93- 96.50	3
fairly controlled	87.50- 93	4
rather desirable controlled	80- 87.50	5
undesirable controlled	70- 80	6
weakly controlled	50- 70	7
poorly controlled	1- 50	8
quite ineffective	0	9

Results and Discussion

Number of pods per plant

The results of the analysis of variance for grain number per plant showed that there was a significant difference between treatments (Table 3). According to the results, hand weeding had the highest number of pods per plant and untreated control (without control) showed the lowest number of pods per plant. Herbicide treatments did not differ in this respect and located in one group (Table 4). The reason for reducing the number of pods per plant in other treatments than manual weeding is probably the form number of flowers and pods is less and increases the amount of flower and pod due to the establishment of stress conditions due to the presence and competition of weeds in the field. In the least competitive conditions, the plant utilizes all the environmental conditions and sufficient development of vegetative parts and the proper production of photosynthetic materials produce the most number of pods, but with the onset of stress and the reduction of production and storage of photosynthetic materials, the number of pods per plant becomes decrease (Tollenaar *et al.*, 1994). The results of other researchers showed that when sufficient space is available to the soybean plant due to a reduction in the population of weeds, the production of pods increases significantly, creates optimal plant canopy, and the optimal use of the created space increases the number of sub-branches and increases the number of pods in soybeans (Egli and Bruening, 2005).

Grain Yield

The results of the analysis of variance for grain yield showed that a significant difference was observed in the traits at the probability level of 1% (Table 3). In this study, soybean yield was the highest for hand weeding. After manual weeding, Ethalfluoralin treatment had the highest grain yield, Metribuzin, Trifluralin and Bentazon treatments had the lowest grain yield with control (uncontrolled), and they did not differ from each other (Table 4). Considering that the Ethalfluoralin herbicide was successful in inhibiting weeds, this increase in yield can be attributed to the positive effect of the application of this herbicide. Among the used treatments, the use of Metribuzin and Bentazon had a lower seed yield, probably due to their negative effect on the soybean plant. It is stated in the report that in soybeans can cause necrosis and lowering of the leaves (Ahrens, 1994). Soybean competition with field weeds and lack of environmental factors affecting the growth caused by this competition, reduces the yield of soybeans, and the highest yield is achieved when environmental conditions such as available humidity, food elements, light, etc. are at the optimum level at all stages of plant growth (Karam *et al.*, 2005).

Protein percent of grain

According to the results, there was a statistically significant difference between treatments (Table 3). The results showed that_untreated control treatment had the highest percentage of protein content and after that, the rest of herbicide treatments and hand weeding treatments did not differ in terms of seed protein percentages and all were in a common group (Table 4). The difference in protein content of soybean seeds may be due to the lack of a complete selection of herbicides in the pre-emergence stage. (Randhawa *et al.*, 2009) reported that grain protein yield was higher in common purslane (*Portulaca oleracea* L.) weed density, which is due to decreased plant growth and low protein content.

Table 3. Analysis of variance of chemical and weeding control effects of the weeds on some morphological, physiological, yield and yield components traits of soybean

S.O.V	df	(Mean square)							
		Height of plant	Growth period	Spad index	Number of pods per plant	1000 Seed weight	Seed yield	Protein percent	Oil percent
Replication	2	9.644^{ns}	1.504^{ns}	1.265^{ns}	7.874^{ns}	72.283^{ns}	0.009^{ns}	1.611^{ns}	0.349
Treatment	7	129.248^{ns}	2.317^{ns}	4.066^{ns}	187.011^{**}	262.340^{ns}	1.791^{**}	0.273^{*}	0.036^{ns}
Error	14	82.418	1.976	6.724	30.302	273.001	0.012	0.184	0.049
C.V (%)		14.31	1.14	5.44	33.56	8.06	8.80	1.15	1.05

Table 4. Mean comparison of the effect of chemical and weeding control of the weeds on some morphological, physiological, yield and yield components traits of the soybean

Treatments	Leaf area index	Number of pods per plant	Seed yield (Kg/ha)	Protein percent (%)
Metribuzin	377.5 cd	12.60 bc	624.7e	37.21 ab
Trifluralin	1041 b	15.17 bc	711.4e	37.08 ab
Ethalfluralin	995.5 bc	21.27 b	1896.3b	37.31 ab
Alachlor	779.7 bcd	13.07 bc	930.2d	37.27 ab
Bentazon	905.2 bcd	14.23 bc	726.1 e	37.29 ab
Imazethapyr	1095.3 b	11.87 bc	1470.4c	37.01 ab
Weeding	1855.2 a	33.92 a	2792.5a	37.34 ab
Without weeding	296.6 d	9.100 c	721.6e	38.04 a
LSD	588.5	9.660	8.80	0.75

The means with similar letter did not show significant differences

Percentage of herbicide effect

The combination of dominant weed species in the field included narrow leaf such_as *Sorghum halepense*, *Echinochloa crus-galli*, *Setaria viridis*, *Abutilon theophrasti*, *Hibiscuc trionum*, and *Amaranthus retroflexus* L. The results of the analysis of variance showed that there was a significant statistical difference between the treatments in terms of the effect of herbicides in two time periods (1%) (Table 5). The results showed that one month after spraying, Trifluralin and Ethalfluralin herbicides had the highest effect on the weed control and two months after spraying, the rest of treatments also showed their effect and all herbicide treatments were in one group (Table 6). (Abbasi *et al.*, 2010), stated that Trifluralin + Oxyloflifene and Alchloric treatments with 95% and 56% had the highest and lowest control efficiency of soybean weed control, respectively. In their experiment, the highest grain yield was obtained from Trifluralin + Bentazon, 2940 kg.ha^{-1} and the lowest amount of grain yield was obtained from Trifluralin + Oxyfluorfen.

Total weed density

The results showed that the treatments had a significant difference in terms of total weed density (Table 5). The results of the comparison of the means showed that according to this study, after weeding application treatment, all of the applied herbicides significantly reduced the weed density compared to the control (uncontrolled) and had the same effect on weed density (Table 6). In a test with application of Imazethapyr with 500, 750 and 1000 ml per ha^{-1} herbicides, pre-emergence and post-emergence and Metribuzin (600 g.ha^{-1} pre-emergence) showed that all amounts of Imazethapyr in the pre-emergence or post-emergence with Metribuzin significantly reduced the weed density compared to the control treatment (Siyahmar ghuee *et al.*, 2017).

Total weed dry weight

Analysis of variance of weed biomass showed that there was a statistically significant difference between the treatments (Table 5). The comparison of the averages showed that weed dry biomass in all treatments were more than weeding. Also, Bentazon herbicide had a less controlling effect on weed dry weight present in this study (Table 6). At the beginning of planting weed seeds, due to the favorable conditions of germination such as irrigation and fertilization, germinated seedlings from these seeds show greater sensitivity to application of pre-sowing herbicides. However, considering the post-application and the contact effect of Bentazon on weeds, it can be concluded that this weed had a lower controlling effect on weed dry weights.

Table 5. Analysis of variance (mean square) of chemical and weeding control on weeds.

S.O.V	df	(Mean square) Herbicide effect percent (one month after use)	Herbicide effect percent (two months after use)	Total weeds density	Total weeds dry weight
Replication	2	0.001ns	0.001ns	8.092ns	89751.292ns
Treatment	7	**0.011	**0.006	**16.803	**1182281.952
Error	14	0.001	0.001	1.389	14708.965
CV (%)		0.98	0.82	16.39	18.37

ns, *, **: non-significant and significant at 5 and 1% probability level, respectively.

Table 6. Mean comparison of chemical and weeding control on weeds.

Treatments	Herbicide effect percent (one month after use)	Herbicide effect percent (two months after use)	Total weeds density (plant/m²)	Total weeds dry weight (g/m²)
Metribuzin	0.33 bc	0.55b	43.33 b	406.7 c
Trifluralin	0.71 ab	0.53 b	30.33 b	398.7 c
Ethalfluralin	0.68 ab	0.43 b	35.33 b	462.1 c
Alachlor	0 c	0.40 b	49.67 b	549.8 c
Bentazon	0.25 c	0.23 bc	58.67 b	1064.21b
Imazethapyr	0 c	0.47 b	35.33 b	361.4 c
Weeding	1 a	1 a	0 c	0 d
Without weeding	0 c	0 c	132.7 a	2034.5 a
LSD	0.3369	0.2769	2.06	212.4

The means with similar letter did not show significant differences

References

Abbasi, R, Alizadeh, H, Zenali Khaneghah, H, Jahromi, KT. (2010). The effects of the integration of mechanical control with herbicides on yield and yield components of soybean (Glycine max (L.) Merr.) in Karaj. *Iran. J. Field Crop Sci.*, 41(2):291-303. (In Persian with English Summary).

Adcock, TE, Banks, PA. (1991). Effects of preemergence herbicides on the competitiveness of selected weeds. *Weed Sci.*, 39(1):54-56.

Adhikari, A, Sapkota, A, Regmi, P, Neupane, S, Sapkota, S, Ghimire, S, Ghimire, D, Kandel, BP. (2019). Effect of establishment method and different weed management practices on dry direct seeded rice (DDSR) at Rampur, Chitwan. *J. Res. Weed Sci.*, 2(4):332-344.

Ahrens, WH. (1994). Herbicide Handbook. 7th ed. Champaign, IL: Weed Science Society of America p. 224-226.

Argaw, A. (2012). Evaluation of Co- Inoculation of Bradyrhizobium japonicum and Phosphate Solubilizing Pseudomonas spp. Effect on Soybean (*Glycine max* L.(Merr.)) in Assossa Area. *J. Agr. Sci. Tech*., 14(1):213-224.

Baysinger, JA, Sims, BD. (1991). Giant ragweed (*Ambrosia trifida*) interference in soybeans (*Glycine max*). *Weed Sci*., 39(3):358–362.

Egli, DB, Bruening, WP. (2005). Shade and temporal distribution of pod production and pod set in soybean. *Crop Sci*., 45(5):1764-1769.

Fellows, GM, Roeth, FW. (1992). Shattercane (*Sorghum bicolor*) interference in soybean (*Glycine max*). *Weed Sci*., 40(1):68–73.

Gaikwad, RP, Pawar, VS. (2002). Chemical Weed Control in Soybean. *Ind. J. Weed Sci*., 34(3, 4):32-35.

Jadhav, AS. Gadade, GD. (2012). Evaluation of Post-Emergence Herbicides in Soybean. *Ind. J. Weed Sci*., 44(4):259– 260.

Jadhav, A, Bhosale, G. (2018). Effect of different herbicides on weed control in cotton and soybean intercropping system. *J. Res. Weed Sci*., 1(2):123-128.

Jhala, AJ, Malik, MS, Willis, JB. (2015). Weed control and crop response of micro-encapsulated acetochlor applied sequentially in glyphosate-resistant soybean. *Can. J. Plant Sci*., 95(5):973–981.

Karam, F, Masaad, R, Sfeir, T, Mounzer, O, Rouphael, Y. (2005). Evapotranspiration and seed yield of field grown soybean under deficit irrigation conditions. *Agric Water Manag*., 75(3): 226-244.

Khakzad, R, Valiallahpour, R, Gholipour, A, Norani, C. (2012). The effects of planting date of soybean cultivars and herbicides on the species density of weeds. *J. Plant. Protec*., 2(4):395-407. (In Persian with English Summary).

Pinke, G, Blazsek, K, Magyar, L, Nagy, K, Karácsony, P, Czúcz, B, Botta- Dukát, Z. (2016). Weed Species Composition of Conventional Soyabean Crops in Hungary is Determined by Environmental, Cultural, Weed Management and Site Variables. *Weed Res*., 56(6):470-481. doi: 10.1111/wre.12225.

Randhawa, MA, Khan, MAJ, Khan, NH, Asif, M. (2009). Influence of *Trianthema portulacastrum* infestation and plant spacing on the yield and quality of maize grain. *Int. j. agric. biol*., 11(2):225-227.

Siyahmar ghuee, A, Nasuti, B, Bagherani, N. (2017). Integrated management of soybean weeds with plant density and Imazethapyr herbicide in Gorgan condition. *App. Res. Plant. Eco*., 3(2):85-101. (In Persian with English Summary).

Taylor-Lovell, S, Wax, LM, Bollero, G. (2002). Pre-emergence flumioxazin and pendimethalin and post-emergence herbicide systems for soybean (*Glycine max*). *Weed Technol.*, 16:502–511.

Tollenaar, M, Dibo, AA, Aguilera, AA,Weise, SF, Swanton, CG. (1994). Effects of crop density on weed interference in maize. *Agron. J.*, 86(4):561-595.

Thurlow, DL, Buchanan, GA. (1972). Competition of sicklepod with soybeans. *Weed Sci.*, 20(4):379–384.

Tourn H, Uygur FN. (2019). Effect of Crop Rotations on Winter Wild Oat (*Avena sterilis* L.) Populations in Osmaniye Province Wheat Sown Areas. *J. Res. Weed Sci.*, 2(4):345-357.

Van-Acker, RC, Swanton, CJ, Weise, SF. (1993). The critical period for weed control in soybean (*Glycine max*). *Weed Sci.*, 41(2):194–200.

Vollmann, J, Wagentristl, H, Hartl, W. (2010). The Effects of Simulated Weed Pressure on Early Maturity Soybeans. *Eur. J. Agron.*, 32(4):243-248.

Yousefi, AR, Gonzalez-Andujar, JL, Alizadeh, H, Baghestani, MA, Rahimian Mashhadi, H, Karimmojeni, H. (2012). Interactions between Reduced Rate of Imazethapyr and Multiple Weed Species– Soyabean Interference in a Semi-Arid Environment. *Weed Res.*, 52(3):242–251.

Zarco-Tejada, PJ, Miller, JR, Mohammed, GH, Noland, TL, Sampson, PH. (2000). Chlorophyll fluorescence effects on vegetation apparent reflectance: II. Laboratory and airborne canopy-level measurements with hyperspectral data. *Remote Sens. Environ.*, 74(3):596-608.

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